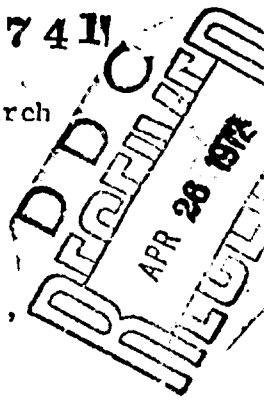
Summary of Research

AFOSR 69-1659



I. Objectives

A. To develop a comprehensive data support system for research in Human Physiology. This system should contain:

1. An effective means for indexing and retrieving bibliographic references.

2. A system for storing and selectively retrieving experimental data derived from experimental studies, published reports or simulation runs. This system should, in addition, permit the interactive comparison and analysis of data of this type.

3. Techniques for the on-line acquisition of experimental data in machine-readable form.

4. Methods to facilitate the creation, execution and analysis of digital simulations of human performance mechanisms.

B. To begin collection of data describing human performance under a variety of environmental and work stress conditions, and from subjects ranging in age from early adult to the late sixties, including normal, athletic and diseased subjects.

C. To start development of a predictive model of human performance.

D. To apply the techniques developed in the project to problems of significance to the Air Force.

E. To assist in implementing the tools developed in other Air Force research institutions.

II. Results

Some progress has been made in all of the areas noted above. The highlights of this progress are summarized below.

A. Bibliographic support. A technique has been developed for the computer indexing of articles that would ordinarily form a reprint file on a particular area of research interest. This technique, although it can be applied to any topic, has been specifically implemented in support of libraries relating to human performance, energy exchange and peripheral circulation. The articles themselves have been microfilmed, placed in microfiche jackets, and duplicated for distribution to other institutions sharing interests in these topics. Equipment was purchased through this grant to support preparation and viewing of the microfiches. This technique is described more fully in refs. 1, 2, 5, 6, 7, 9, 28.

B. Data storage, analysis and comparison system. A computerized data storage system was developed in the early phases of the project. This system operated on a dedicated IBM 7044 computer using a graphic terminal. The system was used for the analysis of human performance data as well as for a variety of other applications. Subsequently, the system was partially converted during the

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

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2a. REPORT SECURITY CLASSIFICATION

UNCLASSIFIED

2b. GROUP

3. REPORT TITLE

INVESTIGATION OF FACTORS AFFECTING HUMAN PERFORMANCE

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Scientific Final

5. AUTHOR(S) (First name, middle initial, last name)

Richard F. Walters

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
25 February 1972	6	34

8a. CONTRACT OR GRANT NO.	AFOSR-69-1659	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	9777	
c.	61102F	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AFOSR - TR - 72 - 0741
d.	681312	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
TECH,OTHER	Air Force Office of Scientific Research (NL) 1400 Wilson Boulevard Arlington, Virginia 22209

13. ABSTRACT

A predictive model of human performance has been under fairly constant revision as new experimental and other information becomes available and is incorporated into the model's design. The model illustrates techniques of interactive simulation, including tutorial assistance for the researcher unfamiliar with its operation, interruptible execution for adjustment of workload or environmental characteristics, and the ability to interrogate the status of any changing variable in the model. Models of acceleration and of the effects of long term exposure to extremely low humidity are in early phases of analyses. Products developed through this project have been made available to USAF in several forms. Microfiched bibliographies have been sent to AMRL, SAM, and the Air Force Academy; computer programs have been installed at the Academy, and experimental data from the Academy have been sent to Davis for preparation in machine readable form.

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project's support period to a third generation timesharing system utilizing remote terminals. Complete descriptions of the system are contained in refs. 1, 9, 24, 28.

C. Techniques for on-line data acquisition. After a detailed review of computer support systems, a Raytheon 703 was purchased through project support funds to provide on-line data acquisition support. This system was extensively used in the latter portion of the support period to collect data on normal and highly trained subjects. Investigation of the most reliable transducers to feed data into the system led to the acquisition of auxiliary equipment, including a mass-spectrometer and a pneumotachometer. The entire system has been under continuing development through the support period, and it is now believed to be reliable, accurate and efficient as a means for capturing experimental data in machine form.

In addition to developing a hardware facility, the project has produced a software system that greatly facilitates preparation of programs designed to accept and store experimental data. The package thus developed has been made available to other Raytheon installations connected with Air Force related research. See refs. 2, 11, 28.

D. Simulation support. Project support has led to development of several simulation capabilities. Initially, an interactive version of MIMIC was developed for use on the IBM 7044. This system was used to study reactive hyperemia and other problems of peripheral circulation. Subsequently, a more sophisticated simulation language, CSMP (Continuous Systems Modeling Program) was converted to the new campus computer, initially in batch form and then in a timeshare version that incorporates interrupt capability as well as plots of any variable against any other. See refs. 1, 2, 10, 23, 25, 28.

E. Collection of human performance data. A considerable library of experimental data is developing as a result of project support. In its initial phases, 80 normal middle aged males were evaluated by a progressive treadmill test. In addition, 11 patients who had undergone coronary surgery or who were recovering from heart attacks were evaluated by a similar test. Results of these experiments were computerized, analyzed by means of the initial version of the interactive analysis system, and the results reported in several publications.

Several experiments conducted in part through Air Force support produced information on the effects of altitude on performance. These studies were conducted both in real altitude conditions (White Mountain Research Station) and in simulated high altitude using a hypobaric chamber. See refs. 28, 29.

F. A predictive model of human performance. Late in the second year of the project, a preliminary model of human performance was developed under project support. This model was implemented on a remote terminal connected to a timeshare system. It has since been under fairly constant revision, as new experimental and other information becomes available and is incorporated into the model's design. The model illustrates techniques of interactive simulation,

including tutorial assistance for the researcher unfamiliar with its operation, interrutible execution for adjustment of workload or environmental characteristics, and the ability to interrogate the status of any changing variable in the model. See refs. 32.

G. Application of techniques to problems affecting Air Force. In response to requests from Air Force research institutions, the project staff have undertaken several specific problems. One has related to the development of a model of acceleration, and is in the early phases of analysis. A second question dealt with effects of long term (several hours) exposure to extremely low humidity. This problem has also been studied in preliminary form, and has led to definition of further improvements in the performance model which are currently being implemented. Other problems were outlined late in the support period and are receiving attention at this time, following completion of the grant support period.

Project members also visited several Air Force research institutions to discuss areas of mutual interest and to share results of this project's research with Air Force personnel. In addition, representatives of several groups have visited the Davis facilities.

H. Extension of research tools to Air Force institutions. The products developed through this project have been made available in several forms. Microfiched bibliographies have been sent to Wright Patterson, Brooks School of Aerospace Medicine and the Air Force Academy. Computer programs have been installed at the Academy. Experimental data from the Academy have been sent to Davis for preparation in machine readable form. Several efforts have been made to establish telephone connection to computer programs available at the Davis campus. These efforts are continuing.

III. Summary

The project proved the value of an interdisciplinary approach to the analysis of problems in human performance. The principal gains to date have been in the development of new computer techniques for research support. The project has generated considerable interest as a result of these new methods. At present, the research effort initiated through grant support is continuing the resolution of problems initially established, using the format and techniques developed during the initial support period.

List of Materials Produced Through Project AFOSR 69-1659

Reports Submitted to Office of Scientific Research:

1. Project Review Summary, October 1969.
2. Project Review Summary, October 1970.
3. Abstract of report presented at Brooks School of Aerospace Medicine, September 1971.
4. The project staff meets at approximately weekly intervals to consider various aspects of the research. Minutes of these meetings have been prepared regularly and are distributed to AFOSR, to AMRL in Wright Patterson and at Brooks, and to the Life Sciences and Electrical Engineering Departments at the Academy.

Bibliographies:

5. Microfiche library on human performance. Approximately 630 references distributed during project support period to groups listed in (4) above.
6. Microfiche library on peripheral circulation. Approximately 470 references distributed as above.
7. Microfiche library on energy exchange. Approximately 320 references distributed as above.

Computer Programs:

8. Human performance prediction model: installed at Air Force Academy.
9. Bibliographic support program system installed at Air Force Academy.
10. CSMP (interactive system) installed at Air Force Academy.
11. Raytheon systems support library: developed at UC Davis, now in process of implementing at Wright Patterson Air Force Base.
12. On-line data analysis system. Currently under revision to convert and expand for implementation on new computer. Initial version inactive.

Papers Presented at Meetings:

13. Digital Interactive Simulation System: Summer Computer Simulation Conference, San Francisco, California, 1969.
14. Digital Interactive Simulation: presented at Gordon Conference in Biomathematics, Proctor Academy, New Hampshire, 1969, July.
15. On-Line Data Analysis: Presented at Annual Scientific Meeting of Aerospace Medical Association, St. Louis, Missouri, April, 1970.
16. Use of Computer Graphics in Simulation: Fall Joint Computer Conference, November, 1970, Las Vegas, Nevada.

17. Use of Computer Graphics in Simulation: School of Medicine, Stanford University, Stanford, California, October, 1969.

18. Computer Simulation with Bibliographic and Data Support in Physiology, invited paper, teaching session, American Physiological Society, Atlantic City, New Jersey, April, 1970.

19. Teaching and Research Through Computer Simulation: Report presented to Joint Automatic Control Conference, Atlanta, Georgia, June, 1970.

20. A Model of Peripheral Circulation: Report presented at Summer Computer Simulation Conference, Denver, Colorado, July, 1970.

21. A Predictive Model of Human Performance: Report presented at Summer Computer Simulation Conference, Boston, Massachusetts, July, 1971.

Scientific Exhibits:

22. Computer Support of Physiologic Research: Scientific Exhibit at Annual Scientific Meeting of Aerospace Medical Association, April, 1970.

Motion Pictures:

23. A Digital Interactive System for Simulation. 16 min., color, sound, produced at U.C. Davis, May, 1970.

24. Computer Supported Training in Physiology. 14 min., color, sound, produced at U.C. Davis, February, 1971.

Theses Written as Part of Project:

25. Renoud, C.R.C., "Digital Interactive Simulation," M.S. thesis in Engineering, University of California, Davis, 1969.

26. Hsu, T.G., "A Model for the Peripheral Circulation and Heat Transfer of the Human Finger," University of California, Davis, 1970.

Publications:

27. Renoud, C.R.G., and Richard F. Walters, CSSL Conference on Applications of Continuous System Simulation Languages, "The Interactive Creation, Execution and Analysis of Biological Simulation Using MIMIC on a Graphic Terminal," June, 1969.

28. Walters, R.F., Brin, K.P, Roth, F., Morrison, J., Renoud, C.R.G., "Information Support Systems for Experimental Investigation," Computers in Biology and Medicine, an International Journal, Vol. 1, pp. 75-86, 1970.

29. Adams, W.C., Carlson, L.D., Keiley, J.S., Renoud, C.R.G., Walters, R.F., "Interactive Techniques for Analysis of Human Performance," presented at Aerospace Medical Association Meeting, April, 1970.

30. Walters, R.F., and R. El. Smith, "Biological Control Systems: Teaching and Research through Interactive Computer Graphics," presented at American Society for Mechanical Engineers meeting, June, 1970.

31. Hsia, T.C., and T.G. Hsu, "A Model for the Peripheral Circulation and Heat Transfer of the Human Finger," presented at June CSSL meeting, 1970.

32. Walters, R.F., and Carlson, L.D., "A Predictive Model of Human Performance," Proceedings of the 1971 Summer Computer Simulation Conference, July 19-21, 1971, Boston, Massachusetts, pp. 911-918, 1971.

33. Walters, R.F., Carlson, L.D., "An Interactive System for the Utilization of Scientific Information," Review of Air Force Sponsored Basic Research in Environmental and Acceleration Physiology, September 28-29, 1971, at Aerospace Medical Division Air Force Systems Command Brooks AFB Texas, 1971.

Workshops:

34. Workshop on peripheral circulation, held at U.C. Davis, June, 1971. Attended by project staff plus Dr. Keith Cooper and Dr. John Krog.

END

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